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A Comparison of Invasive and Native Plants in an Abandoned Limestone Quarry

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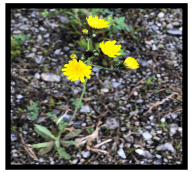
Introduction: The abandoned limestone quarry in the DePauw Nature Park from which limestone gravel was extracted from 1917-1977 comprises a harsh, heterogenous, and fluctuating environment, as is illustrated by the two images below taken approximately one year apart. Because the limestone floor of the quarry is a novel anthropogenic environment, every plant species in the quarry had to be introduced somehow. Perhaps native species that are able to establish populations in the quarry are more likely to share traits with invasive species. **This study focused on the potential overlap of traits between native and invasive plants of similar forms that grow in the quarry.**

Methods: Using information collected from scientific articles, I compared the life history traits of three pairs of plants with similar forms. This information was used to look for patterns to give preliminary information about biological traits that are linked to invasive species compared to native species of similar forms that are found in the quarry. The plants compared were two flowering herbaceous species, two woody vines, and two invasive wetland grasses which appear to differ in their prevalence in the quarry. Life history traits that may be associated with invasiveness are listed below the images of the plants with green arrows, and traits that had significant mean effects in a meta-analysis[3] of invasive research papers are listed next to the orange arrows.

Erigeron annuus - Native

- Wind dispersed seeds
- Multiple methods of seed dispersal
- Asexual reproduction – apomictic
- Highly adaptable

Pilosella caespitosa - Invasive



- Wind dispersed seeds
- Multiple methods of seed dispersal
- Asexual Reproduction – stolons, apomictic
- Genetic plasticity

- Completes lifecycle quickly
- Thrives in low-productivity soils

Erigeron annuus and *Pilosella caespitosa* are both very common species throughout the quarry. This literature review suggests that the differentiating factor for the categorization of one as invasive and the other as native is their origin rather than their traits.

Typha angustifolia Invasive

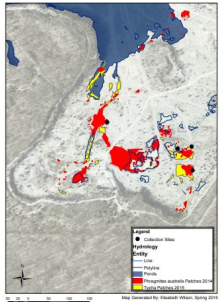
- Wind dispersed seeds
- Multiple methods of seed dispersal
- Asexual reproduction – rhizomal
- Highly adaptable

- Seeds germinate quickly
- Large size
- Rapid growth rate
- Efficient use of oxygen

Why compare *Typha* and *Phragmites*?

Though *Phragmites australis* and *Typha angustifolia* are both invasive species in central Indiana but *Phragmites* is more widespread in the quarry, as is shown in the map below. Why? The literature review shows that these species share many invasive traits; therefore, more exploration is needed to explain their differential success in the quarry. Do the production of flowers, seed germination, growth rate, and/or root/shoot ratio vary between these species in the quarry? The wetland status may be a differentiating factor as *Phragmites* is a "facultative upland species" whereas *Typha* is an "obligate wetland" species, how might this affect their ability to establish in the quarry?

2014 Map of Phragmites and Typha Populations in the Quarry



Phragmites australis Invasive

- Wind dispersed seeds
- Multiple methods of seed dispersal
- Asexual reproduction – rhizomal
- High phenotypic plasticity

- Short generation time
- High resource capture
- High photosynthetic capacity

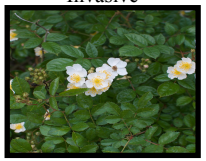
Results and Discussion: All six focal species exhibited traits that are associated with invasiveness. The species studied all exhibit some form of asexual reproduction. This is a propitious trait to have in an environment as inhospitable as the quarry because seed survival can be a limiting factor to plant community establishment due to the limited nutrient availability in the soil, as well as the lack of soil. All but the two vines have wind-dispersed seeds, and all but two have multiple distinct means of dispersal. Dispersal is relevant due to the necessity of introduction into the quarry from the surrounding plant communities. Four of the six species have high genetic or phenotypic plasticity, a trait that has often been associated with invasive species. In a highly heterogeneous environment like the quarry, this is an advantageous trait. A meta-analysis of research papers about invasiveness by Van Klunen et al. outlined traits that have significant mean effect sizes provided another framework for comparing species that can be pursued further in the future when more empirical data is available.

Celastrus scandens Native

- Multiple methods of seed dispersal
- Asexual reproduction – root suckering

- Rapid growth rate

Rosa multiflora Invasive



- Asexual reproduction – clonal

Though this list does not indicate it, *Rosa multiflora* is a highly successful invasive species on the margins of forests. It produces many fruits and flowers for long periods of time and can grow in a shrub or vine habit depending on its environment. It was planted as a living fence, for cover, and to prevent soil erosion, a purposeful introduction that may have given this plant an advantage for establishment. *Celastrus* has some similar characteristics but is not as widespread. Both species are less common than the other pairs included in this study which may be resultant from their having fewer adaptations to this environment.

Conclusion: This literature review does not indicate a clear association of specific traits with invasive plants in the quarry, but rather shows that these traits which are often associated with invasiveness appear in **both** the invasive **and** the native species found in the quarry. Perhaps the label of "invasiveness" may not designate a distinct set of biological traits belonging to these plants, but instead has more to do with the species' ecological range. To better understand the differing rates of successful establishment between species in the quarry, more data related to the species' spread and population size in the quarry is needed. Though this study focused on the intersection of native and invasive species, there are other avenues worth exploring which could explain what traits help plants establish populations in the quarry. It may be that the native species that are able to become established in the quarry share traits with species that grow in calcareous outcrops[1] and/or early successional species[2]. Future research focused on comparing invasive traits outlined in the meta-analysis of invasive research papers performed by Van Kleunen et al. as well as calcareous and early successional species' traits would broaden our understanding of what plants thrive in the quarry and why.

References: 1. Baskin, J. M., Baskin, C. C., & Lawless, P. J. (2007). Calcareous rock outcrop vegetation of eastern North America (exclusive of the Nashville Basin), with particular reference to use of the term "cedar glades". *The Botanical Review*, *73*(4), 303-325.

2. Gilardelli, F., Sgorbati, S., Armiraglio, S., Citterio, S., & Gentili, R. (2016). Assigning plant communities to a successional phase: time trends in abandoned limestone quarries. *Plant Biosystems-An International Journal Dealing with all Aspects of Plant Biology*, *150*(4), 799-808.

3. Van Kleunen, M., Weber, E., & Fischer, M. (2010). A meta-analysis of trait differences between invasive and non-invasive plant species. Ecology letters, 13(2), 235-245. For more references scan the QR code.

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